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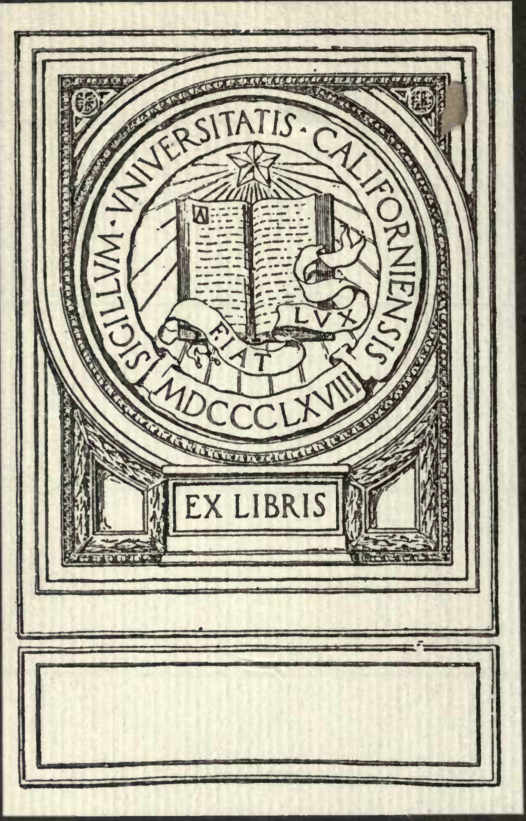
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THE ESTIMATION
OF
FAT IN MILK AND CREAM.

DUBLIN:
PRINTED FOR HIS MAJESTY'S STATIONERY OFFICE,
BY ALEX. THOM & CO. (LIMITED), 87, 88, & 89, ABBEY-STREET.

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THE ESTIMATION OF FAT IN MILK AND CREAM.

It is now the practice in all well-managed creameries to base the price paid for milk on the percentage of fat which it contains. Sometimes cream itself is purchased, and this, too, is valued according to its fat content. On the person, therefore, who is entrusted with the estimation of the percentage of fat, whether in milk or in cream, there rests a heavy responsibility. If he is to do justice to all concerned he cannot too seriously study the instructions herein contained, nor can he bestow too great care on every detail in sampling, testing, and recording.

THE TESTING ROOM AND ITS EQUIPMENT.

It is assumed that every creamery is provided with a well lighted room, properly equipped and used solely for testing, in which the following appliances and reagents are conveniently and neatly arranged:—

1. A steam turbine centrifuge for twenty-four bottles, provided with means of heating the test bottles in winter.

2. An ample supply of test bottles and stands; the former numbered consecutively by means of small brass labels twisted round the neck, and the latter by numbered enamelled strips fixed on the top of the rack between the two rows of test bottles. There should be no duplicate numbers, which are a common cause of confusion and error.

3. A large copper water-bath for forty-eight test bottles, supported on an iron stand, and heated by means of a steam pipe under the false bottom, or by a No. 4 Primus paraffin lamp.

4. Pipettes for measuring out 1 c.c., 10 c.c., and 11 c.c.

5. A 250 c.c. burette for sulphuric acid reading 10 c.c., and a 50 c.c. burette for amyl alcohol reading c.c.

6. A good sink, with a hot-water supply and a set of jets for rinsing test bottles.

7. Some No. 8 or No. 10 shot for mixing samples and cleaning out bottles. As this can be used again and again, only a small quantity is necessary.

8. A supply of washing soda, or some good cleansing powder.

9. A bottle of strong ammonia, specific gravity ·880, provided with a 2 c.c. pipette and rubber filler.

10. A small bottle of strong hydrochloric acid.

11. A hydrometer and trial jar for sulphuric acid.

12. A hydrometer and trial jar for amyl alcohol.

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13. Two large earthenware crocks, one in which to empty the test bottles, and the other containing a strong solution of washing soda for cleaning the bottles.

14. A set of suitable brushes for cleaning test bottles.

15. A 500 c.c. graduated measure, reading 5 c.c.

16. A 100 c.c. graduated measure reading c.c.

17. A stock of sulphuric acid and amyl alcohol.

18. A reliable chemical thermometer (centigrade).

A careful manager will always see that he has the most indispensable of these articles in duplicate, particularly the pipettes and burettes which are liable to be broken.

The sulphuric acid should be of the quality known as "best white commercial," and should have at 15° C. a specific gravity of from 1·820 to 1·825. The former strength is used in summer, and the latter in winter. About a dozen Winchester quarts of the acid should be purchased at a time; it must be kept in stoppered bottles, as it loses strength if exposed to the air. If strong acid of specific gravity 1·840 has been purchased it must be diluted with water as follows:—1 part of water to 10 parts of acid for summer use, and 1 part of water to 12 parts of acid for winter use. Great care must be taken in diluting the acid. The best method is to take two litres, that is, 2,000 c.c., in a Winchester quart bottle, and to add thereto the necessary amount of water in small quantities at a time, taking care to shake the bottle after each addition. If all the water is added at one time the mixture will suddenly become very hot, and may crack the bottle. It is not necessary to have the temperature exactly 15° C. for testing the specific gravity, as any deviation from this temperature can be easily allowed for by adding or deducting ·001 from the hydrometer reading for each degree above or below 15° C.

For testing separated milk or buttermilk a weaker acid than the above should be used. An acid of about the proper strength may be made by adding one part of water to either 55 parts of the 1·820 strength, or to 9 parts of the 1·840 strength. A very good indication that the strength of the acid is correct is afforded by the pale lemon colour which the fat in the neck of the test bottle then assumes. If the fat is very dark the acid is too strong, whereas if the fat is white and has beneath it particles of undissolved curd the acid is too weak.

The amyl alcohol (commonly known as fusel oil) should have a specific gravity of ·815 or ·816 at 15° C., and should boil at 126°-130° C. It should be colourless and free from fat. Its purity in this respect may be tested by mixing equal parts of it and hydrochloric acid and whirling 22 c.c. of the mixture in a test bottle in the centrifuge. Any fat present will collect in the neck of the test bottle; but owing to its pale colour a very careful examination is necessary for its detection. For testing amyl alcohol a special form of hydrometer, the "Tralles," can be obtained. It should read 95-96 if the alcohol is of the proper strength. A Reaumur thermometer is enclosed in the body of this hydrometer, and it should be remembered that 12° R. corresponds to 15° C. Corrections for slight deviations from the standard temperature are marked on each side of the scale of the thermometer.

SAMPLING.

No part of the work requires more care than the taking of such a sample of milk as shall truly represent the bulk. The mere pouring of the milk into the weighing vessel does not ensure thorough mixing. Prior to mixing, however, any particles of fat which may have separated out in transit should be removed. This done, the milk in each can should be agitated by means of a plunger kept for the purpose on a rack alongside the platform. The contents of the cans are then poured into the weighing machine, and the sample immediately taken from the bulk. When the amount of milk delivered by one supplier exceeds the capacity of the weighing machine, a proportionate quantity should be taken out of each can (after using the plunger) and poured into a separate vessel, from which, after a further mixing, the final sample is taken.

The difficulty arising from clots of butter formed during transit might to some extent be obviated if suppliers would stir up any milk that has stood for a considerable time at the farm before despatch to the creamery.

The practice of paying for milk on the basis of a test made at irregular intervals is not satisfactory. The proper method is to take daily samples of each delivery and to let these accumulate for a fortnight or month, and to then test the composite sample. This method has all the advantages of daily testing and effects a considerable saving of labour. Moreover, each lot of rich milk and of poor milk is represented in the composite sample. For working composite sampling the following articles should be provided:—

1. Two sets of bottles, of 8 oz. or 16 oz. capacity, according as the testing is to be done fortnightly or monthly.

2. A lock-up rack, in which the bottles are kept.

3. A ½-oz. tinned steel dipper, to take the samples.

The need for two sets of bottles arises from the fact that one is required for collecting, while the other set is in use in the testing room. The bottles should be of strong glass, without shoulders, and should be furnished with loose glass covers. The mouth should be 1½ inches, and the bottom 2½ inches in diameter. Ground glass stoppers, or stoppers with cork bands, have proved unsatisfactory. The bottles must be securely labelled, and for this purpose nothing is better than painting on them figures about 1 inch high in Aspinall's black enamel.

To secure speed in sampling, hold the dipper in the right hand and the sample bottle in the left, lift off the cover with the right hand, fill the dipper, empty it into the bottle, and replace the cover.

Pellets of a preserving agent must be used to prevent souring. These pellets can be purchased in two sizes, a ·25 gram size, to preserve 8 oz. for a fortnight, or a ·5 gram, to preserve the same quantity for a month. A pellet should be placed in the bottle before the first sample is added. It will be found an advantage to add at the same time a few grains of small shot, which will assist in the future mixing. When the sampling is over for the day give each bottle a gentle rotary motion. This serves the double purpose of mixing the contents and of preventing the formation of a layer of dry cream, which would be found difficult to deal with in the testing. The use of any excess of the preserving agent should be avoided, as this practice gives rise to difficulties in testing. The preserving agent is extremely poisonous, and the contents of the test and sample bottles should, therefore, be emptied in some safe place.

If a sour sample has to be tested add a few grains of shot and mix well. By means of a graduated measure take 100 c.c. and add thereto 2 c.c. of strong ammonia, mix well, and allow to stand until on shaking air bubbles rise as freely as they do in fresh milk. The sample may then be tested in the usual manner if the observed percentage of fat be increased by 1-50th of itself to correct for the dilution by ammonia.

To send samples from auxiliaries to a central creamery use 4 oz. narrow-necked bottles, which, after the addition of a few grains of shot, should be completely filled to prevent churning in transit.

PREPARATIONS FOR TESTING.

When only a few tests are required the pipettes specified in No. 4 of the equipment, on page 3, will be found sufficient. When, however, a large number of tests have to be made it will be found more convenient to measure the acid by the burettes specified in No. 5 of the equipment on page 3.

It is desirable that the testing room should contain more than one test bottle of guaranteed accuracy, to serve as a standard of comparison. Pipettes and bottles are tested under the supervision of the Director, National Physical Laboratory, Old Deer Park, Richmond, Surrey, at a fee of 3*d.* for each pipette, and 6*d.* for each test bottle. The carriage on such articles must be prepaid.

Any test bottle which gives mean results differing by more than ·05 per cent. from the results obtained in the standardised bottle should be discarded.

USE OF APPARATUS.

To enable a manager to do full justice to his employers and to milk suppliers he should, by preliminary practice in the use of the graduated apparatus, make himself familiar with their construction and thoroughly adept in their use. Not until such time as he has acquired a complete command of the apparatus and operations should he presume to decide authoritatively on the milk supplied. The following short description of the construction and use of the apparatus may be found helpful; but practice alone will give the needful dexterity and accuracy. Useful practice may be obtained by repeated tests of the same sample of milk. If without any failures he is able to secure uniform results with one and the same sample he may proceed with the official testing.

i. Pipettes.

The correct method of handling the pipette is as follows:—Place the ball of the forefinger of the right hand on the upper end of the pipette—the finger being moist but not wet. Slide the thumb and other fingers as far down the stem as possible. In this way a firm and easy grip is ensured, and the slightest easing of the pressure of the forefinger will allow the liquid to flow out steadily. To fill, immerse the lower end of the pipette well into the liquid, apply the mouth to the upper end and draw up the milk until it stands slightly above the mark on the stem. Then deftly replace the forefinger before the liquid sinks. Some considerable practice may be necessary to enable the operator to control the flow of the milk from the pipette, and to stop it when the liquid is at the mark. With clear liquids the bottom of the dark curve or meniscus should be at the mark, with opaque liquids, such as milk, the transparent edge of the liquid should be just above the mark.

In determining the position of the milk with relation to the mark, hold the pipette in a vertical position, with the mark on a level with the eye. In emptying the pipette keep it in a vertical position, and give it a rotary motion by means of the thumb and forefinger, so as to prevent any fine particles of fat adhering. When empty touch the side of the receiving vessel with the point of the pipette to get rid of the last drop. Do not blow through the pipette. The small amount of milk which remains in the point is allowed for by the maker in marking.

ii. Test Bottles.

The neck of the test bottle is divided into ninety parts by lines of varying length. To facilitate reading each tenth mark is lengthened and each fifth mark slightly lengthened. In reading, hold the bottle in a vertical position and in a good light.

Press up or ease the stopper till the bottom of the column of fat coincides with one of the longest marks. If now it is remembered that, when 11 c.c. of milk have been used in the test, the space between two long lines represents 1 per cent. of fat, and that between two shorter lines 0·1 per cent., it will be found extremely easy to read off the percentage of fat in any sample. A careful reader should be able to read to ·05 per cent. Read from below upwards, and again from the top downward. A very common source of error occurs at this juncture owing to the column of fat moving its position during the time occupied in taking the two readings. The top of the fat column is curved. The bottom of the dark curve is the correct point to read when whole milk is being tested. The fat should be free from any appearance of bubbles at the bottom of the column. If bubbles are present they indicate that the whirling was insufficient. When a dirty layer or a layer of undissolved curd appears between the fat and the acid solution it indicates that the acid is too weak or that the bottle has not been sufficiently shaken—if black that the acid is too strong, that the milk has been dropped into the acid instead of being poured down the side of the bottle, that the bottle has been dirty, or that the stopper is in bad condition. Bubbles on the surface of the fat may be got rid of by giving the bottle a sharp tap on the table. If in attempting to remove the bubbles, or if in moving the stopper of the bottle while reading, any fat is spurted into the neck the bottle must be whirled again.

The marks on the test bottle are usually cut deeply into the glass, and should be quite distinct. If they are not distinct, a little black varnish should be rubbed over the neck, so as to make the divisions stand out boldly.

The india rubber stoppers should be reversible, and in order that they may be securely held in position the neck of the test bottle is usually moulded so that the inner surface resembles the thread of a screw.

For testing butter-milk or separated milk, a newer pattern of bottle, called a "precision" bottle, has been invented. In this form the upper portion of the stem is narrowed, and the space between each division correspondingly lengthened so that a small percentage of fat can easily be read. These bottles should not, however, be used for testing whole milk.

iii. Burettes.

Where a large number of samples have to be tested it will be necessary to measure the sulphuric acid and the amyl alcohol with burettes, and to discard the use of the pipettes supplied for measuring these reagents. The burette for the sulphuric acid should be replenished from a stock bottle placed on a stand sufficiently low to prevent syphoning. A little practice will be required to enable the operator to freely run off 10 c.c. of acid and 1 c.c. of amyl alcohol.

TESTING.

Before beginning the test see that all the apparatus is perfectly clean, that everything is in its place, and that a test book, headed as follows, lies open on the table:—

TESTING RESULTS. DATE ——— 19—.

No. of Test Bottle.	No. of Sample.	Per Cent. Fat.	Per Cent. Fat in Repeat Test.
	Twenty-four	lines to page.	

When a large number of tests have to be made twenty-four bottles should be used simultaneously. The first operation is to run off into each bottle 10 c.c. of sulphuric acid, then by means of the pipette provided for the purpose 11 c.c. of the sample of milk mixed as described below is run into each bottle, entering in the test book at once the number of the bottle and the number of the sample.

[There is no part of the testing which needs closer attention or more skill on the part of the operator than that of taking a fair specimen of the composite sample of milk. The need for care arises from several considerations. In the first place, cream will have risen, and may have dried on the surface, rendering difficult the getting it again thoroughly incorporated with the bulk. In the second place the shaking, to secure thorough mixing, gives rise to air bubbles which require a certain time to escape. It is almost needless to point out that if the milk be measured with air bubbles in it a quite inaccurate result will be obtained. Accordingly, it is necessary, after the composite sample has been thoroughly shaken, to allow it to stand awhile; but in the interval cream may have again risen, and consequently some system must be adopted which ensures thorough mixing, freedom from air bubbles, and a minimum loss of time. To accomplish these ends the following procedure has been found most satisfactory:—Before commencing to shake the samples look carefully for any in which the cream has dried on the side of the bottle, and also for any in which churning has taken place. In both these cases warm the sample to 38° C. to melt the fat, then shake vigorously, and cool under the water tap, taking great care that no water enters the bottle. Now arrange all the samples in numerical order, and commence to mix the contents of each bottle by shaking vigorously, using the palm of the hand as a stopper. After the first three bottles have been shaken return to No. 1, which by this time should be free from air bubbles. Gently invert bottle No. 1, again closing with the palm of the hand. Replace the bottle on the table, and take from it for the test 11 c.c. of milk free from air bubbles. Now shake the contents of bottle No. 4, after which return to No. 2, and take a sample, then shake No. 5, then sample No. 3, and so on. Always examine the milk in the pipette. If any bubbles are observed, empty, mix the sample as described above, and refill the pipette.]

After the milk 1 c.c. of amyl alcohol is added to each bottle. If the operations have been properly performed there should be now three layers of liquid each sharply defined. To secure this the milk and the amyl alcohol should be run down the side of the test bottle and not dropped directly into it. The bottles are now securely closed by the rubber stoppers, which should be dry, soft, and free from cracks and granular matter. Each bottle in turn is then well shaken, the thumb being held on the stopper to prevent slipping. As considerable heat is developed a piece of thick flannel, about 4 inches square, with a hole in one corner for the thumb, may be used to protect the hand. When the contents of a test bottle are well mixed turn it upside down to permit the acid in the neck to run into the body of the bottle. Shake till the curd is completely dissolved.

When less than half a dozen samples are to be tested the bottles may be straightway placed in the centrifuge. If, however, as is usually the case, a larger number of bottles are in use, each should be placed, stopper end up, as soon as it is mixed, in the water bath at a temperature of from 65° C. to 70° C. The water in the bath should be up to the shoulders of the bottles. When a set of bottles has thus been prepared place them in the centrifuge and whirl for three minutes. In cold weather the body of the centrifuge should be heated, or the samples will cool too quickly to allow complete separation of the fat. The speed of the centrifuge should not be excessive. A few trials will enable the operator to determine the correct speed. When all the places in the centrifuge are not required the bottles should be so distributed that the weight is balanced.

The results will not be correct if the bottles are allowed to cool down before reading. This is a common source of error, causing differences of from ·05 per cent. to ·1 per cent. As each bottle is read, promptly enter the reading in the test book.

In testing separated milk or butter-milk, "precision" bottles and sulphuric acid 1·816 should, as already indicated, be used, and the reading at the upper curve of the meniscus should be taken. With these milks the bottles should be shaken much longer, and should be left in the water bath for from five to ten minutes before whirling. In addition, the whirling should be continued for at least nine minutes. Should the centrifuge have no provision for heating the bottles while in motion, they should be taken out at the end of each three minutes and heated in the water bath. Should dirt or curd (which always contains fat) separate out immediately below the fat the test must be repeated. To get a correct reading in the case of separated milk or butter-milk is much more tedious than in the case of whole milk.

CREAM TESTING.

The estimation of fat in cream presents exceptional difficulties, and is liable to more serious errors than milk testing, and no one who is not an adept in the use of delicate measuring apparatus can be relied upon to determine the value of cream. With great care, and duplicate testing, however, the amount of fat in cream may be determined with an accuracy sufficient for commercial purposes, and this, too, by the Gerber method.

What has been said with regard to the need for care in the testing of milk applies with equal force to the testing of cream.

The method consists in carefully diluting 11 c.c. of the cream so that it may be tested as if it were ordinary milk, and afterwards making the proper allowance for the degree of dilution. Still another method whereby the cream is actually weighed might be adopted; but this requires the use of a delicate balance with which creamery managers are not often supplied. Anyone, however, who has such a balance, who has been thoroughly trained in its use, and who wishes to employ this method, may obtain the necessary apparatus and full instructions from any agent supplying the Gerber tester.

The peculiarity in the case of cream which gives rise to most of the difficulty in testing is its viscosity, a property which greatly favours the retention of air bubbles. Accordingly, before cream can be tested with accuracy it must stand at least two hours after separation, so that the excessively fine air bubbles, often so fine as to escape the eye, may have had time to escape from the mass. Cream from an auxiliary should be thoroughly mixed, before the sample is taken, and should not contain more than 0·2 per cent of acid.

Before taking the quantity requisite for a test the sample, which should have stood for at least half an hour, must be thoroughly mixed, and to do so it should be first warmed, if necessary, to 20° C., and then carefully stirred with a spoon. In dealing with very viscous cream it may be necessary, first, to warm it to 50° C., and afterwards to cool down to about 20° C., before taking the sample. On no account should the sample be shaken or air bubbles will be included. When properly mixed, take the test sample with a dry pipette which has been certified accurate. Draw the cream slowly into the pipette and only slightly above the mark. Before adjusting the liquid to the mark carefully wipe off the cream adhering to the outside of the pipette. When the top of the column of cream has been lowered to coincide with the mark, remove the drop hanging from the point of the pipette and discharge the cream into a clean dry bottle or conical flask of about 300 c.c. capacity. The same pipette should then be filled with clean water exactly to the mark, and the contents delivered into the cream. Again fill the pipette with clean water and deliver into the cream. This must be repeated till the mixture of cream and water contains less than 9 per cent. of fat. The measuring of the water into the cream will, of course, ensure that no cream remains in the pipette. Generally, it may be stated that for a 25 per cent. cream two pipettefuls of water will be sufficient; for a 25 per cent. to 35 per cent. cream three pipettefuls; for a 35 per cent. to 45 per cent. cream four pipettefuls, and so on. Excess of water above that required to dilute the cream to below 9 per cent. should be avoided.

Extreme care is now required in taking from the diluted cream the 11 c.c. with which to make the test. The need for care arises from the fact that the fat in a mixture of cream and water rises very rapidly, while a violent mixing gives rise to air bubbles which completely vitiate the results. The best method is to first thoroughly shake the mixture, allow it to stand for a few minutes, and then mix again by a gentle rotary motion of the vessel, and immediately draw off the 11 c.c., which should then be delivered into a test bottle, to which 10 c.c. of sulphuric acid has previously been added, as in ordinary testing. The further procedure is identical with that followed in the case of milk.

The percentage of fat should be read quickly at 65° C. The bottles are then immediately placed in the centrifuge, heated, and again read at 65° C. If the two readings do not agree the sample should be whirled and read a third time.

It is absolutely necessary to make two separate dilutions of the sample from each consignment of cream, and two tests of each dilution. Thus, four estimations of each cream are obtained, and, provided that the extreme difference between these is not greater than ·1 per cent. the average of them may be taken to represent the percentage of fat in the diluted sample.

To obtain from these data the percentage of fat in the original cream multiply the average of the four tests by a number greater by one than the number of pipettefuls of water added, and correct the figure thus found from the following table:—

TABLE OF CORRECTIONS.

Per cent. Fat found.	Correction to be added.	Per cent. Fat found.	Correction to be added.	Per cent. Fat found.	Correction to be added per cent.
20	·12	30	·48	41	1·17
21	·16	31	·54	42	1·24
22	·19	32	·60	43	1·32
23	·23	33	·66	44	1·40
24	·26	34	·72	45	1·48
25	·30	35	·77	46	1·56
26	·34	36	·83	47	1·64
27	·38	37	·90	48	1·72
28	·42	38	·96	49	1·80
29	·45	39	1·03	50	1·89
—	—	40	1·09	—	—

In carrying out this test the following sources of error should be avoided:—(1) Sour cream; (2) use of wet pipettes or flasks when first measuring out the cream; (3) careless mixing, whereby air bubbles are drawn into the pipette along with the cream; (4) drawing the cream too far above the mark in the pipette; (5) loss of fat when adding water for dilution; (6) imperfect mixing of the diluted cream; (7) fine particles of fat left on the pipette when the diluted cream is run into the test bottle; (8) reading the results at too low or too high a temperature.

CLEANING THE TEST BOTTLES.

A capable manager may often be known by the state in which he leaves the testing room after the day's work: his bottles are carefully washed and put away, every piece of apparatus is clean and in its proper place, his working bench is free from dirt or from liquids spilt during testing, and the centrifuge is cleaned and carefully wiped dry. On the other hand, the manager who leaves everything uncleaned or in a half-cleaned condition, bottles greasy, corks unwashed or wet, reagents out of place and the bench sloppy, is utterly unworthy of his position, and it is not possible that the milk suppliers can receive justice if they are paid on his figures.

Test bottles, to be thoroughly cleaned, should be emptied while the contents are hot, and to secure this they should be kept, stopper end up, in the hot-water bath after reading at the close of a test. Before emptying they should be vigorously shaken so as to loosen the white deposit under the stopper.

They should then be well rinsed out with hot water. This will often be sufficient to clean them; but if any of them show any signs of greasiness they should be soaked in a strong solution of soda and afterwards rinsed out with hot water. A set of rinsing jets, consisting of narrow tubes sufficiently long to reach to the bulb of the bottles, and which can be screwed on to the hot water supply pipe will materially aid in this part of the work. Test bottles cannot be satisfactorily cleaned if they are allowed to cool before being emptied. The difficulty of obtaining a clear reading is often due to dirty bottles. Moreover, unseen fat left from a previous test in a dirty bottle is very frequently a source of considerable error.

The rubber stoppers need special attention. Immediately after the test these stoppers should be washed in hot water until they are free from acid, and then carefully dried. If left unwashed they become hard and useless. The dirty layer which is often seen under the column of fat is frequently due to granular matter from dirty stoppers.

A. T. & Co. (Ltd.)
5,000 (G. 60) 4. 1903.

Gaylord Bros., Inc.
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